World Journal of Research and Review (WJRR)
ISSN:2455-3956, Volume-6, Issue-1, January 2018 Pages 41-49

Study on the Growth and Yield Potential of Promising Wheat Genotypes under Modified Agronomical Practices

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***Abstract*- A field experiment was conducted to investigate the combined effect of NPKS (Nitrogen, Phosphorus, Potash and sulpher) fertilizer with cow dung on the growth and yield of promising wheat genotypes. Organic matter in the initial soil of the experimental field is very low (0.94%). The objective of study was to investigate the varietal/genotypic in producing maximum yield under different soil and environmental condition. To estimate the nutrient use efficiency of wheat genotypes and to support wheat breeding program in selecting the genotypes with relatively higher yield potential.To determine optimum rate of NPKS for wheat genotypes .The results revealed that maximum growth parameters responded significantly to NPKS fertilizers. Application of NPKS in combination increased wheat yield, gave the highest grain yield (4.21 t ha^{-1}) from M_4 management, due the higher number of grains spike^{-1}over nutrient management. The highest grain yield (4.29 t ha^{-1}) was recorded from G_3 (BAW1161) genotypes. Among the interaction of nutrient management and genotypes produced the highest grain yield (4.60 t ha^{-1}) in M_4G_3 (i.e 150% RF+10 t ha^{-1}cowdung and BAW1161) which may be considered as the best treatment combination. Different genotypes showed variable response to nutrient management.**

***Index Terms* - growth, yield, wheat genotypes, potential yield, agronomical practices.**

I. INTRODUCTION

Wheat *(Triticum aestivum* L.) belonging to family Gramineae provides nutrition to a large world population (Heyne,1987).It is the most important cereal crop and it ranks third both increase and production in the world (UNDP and FAO,2008). It has been established as the second most important staple food crop after rice in Bangladesh. Bangladesh produces 13,48,186 M.tons of wheat per annum from 4,00,000 ha of land(BBS,2016). Cereal crop production like wheat should be increased to meet the demand of the escalating population of Bangladesh, where an individual requires 454 g cereal food per day (BARI, 2004). Agricultural production has risen as fertilizer use has steadily increased (Tilman *et al* .2001).

Huge quantities of N fertilizer are commonly used to achieve high yields in cereals (**Fixen** and **West**, 2002). Potassium (K) is the third macronutrient required for plant growth, after nitrogen (N) and phosphorus(P). Potassium fertilizers are not subject to leaching or volatilization therefore can be applied to a wide range of application K has an important osmotic rolein plants (**Fageria *et al*.**,1991. **Tisdai *et al*.**,1985).

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Approximately 3,518,000 tonnes of winter wheat were harvested from 815,000 ha in 2012, covering almost 33%of the Czech Republic cropland area (**Czech Statistical Office, 2014**). Rational use of organic and mineral fertilizers, based on the knowledge of their chemical composition, can lead to the same results as using mineral forms alone, thus reducing financial costs and not endangering the environment (**Berenguer *et al*.**,2008).

During the process of variety selection trails are conducted under the common (Recommended) rates of fertilizer in different agro-ecological zones. Thus the varietal potentiality in producing maximum yield remained unknown. The yield potentiality of variety Kanchan was reported as 6.5 t/ ha about two decade ago. Recently new varieties have been released which have higher biomass and yield. Some of the new genotypes are short in stature and thus resistant to lodging under the high fertility levels. Also the soil and environmental condition is being changed. Under the changed global conditions, we already experienced that food may not be affordable through import from other countries. Depending on global food policy and production, it may need to maximize wheat production beyond the economic profitability. All crop stages have a short duration, consequently, there are fewer days to accumulate assimilate during life cycle and production of biomass is reduced (**Fischer** and **Maurer**, 1974). It ultimately affects grain filling and lastly the yield of crop. Plant responses to high temperature vary with plant species, variety and phenological stages. Reproductive processes are markedly affected by high temperature which ultimately affects fertilization and post fertilization processes leading to reduced crop yield (Wahid *et al*.,2007).

Nitrogen plays a vital role in growth processes as it is anintegral part of chlorophyll, protein and nucleic acid (**Marschner**,1995 and **Jabber**,2009). NPK application is an important impact factor throughout the world including Bangladesh. Low quality seed, salinity, water logging, inadequate use of fertilizers, lack of irrigation water, high input prices, low farmer's education and no use of micronutrients and organic fertilizers are the major reasons for low wheat production (**Khan *et al*.**, 1999). Micronutrients deficiency is widespread in many Asian countries due to the calcareous nature of soils, high pH, low organic matter, salt stress, prolonged drought, high bicarbonate contents in irrigation water and imbalanced application of NPK fertilizers (**Ahmad ikhah** *et al.,* 2010). As the population continues to rise along with consumption expectations of new emerging economies, and with it food demand, food shortages will be unavoidable if agricultural production gains do not return to previous rates, at least keeping abreast of population growth (**Khush,** 1999). However, improvements in crop productivity to meet the requirement mentioned above will not be easy without further technological breakthroughs that allow yield ceilings to be shifted through the development of new crop varieties (**Rosenzweig** and **Parry**, 1994). Organic matter in the initial soil of my experimental field is very low (0.94%) [Table 1]. In this context, we include cowdung for increase organic matter in soil fertility and productivity. Another NPKS are the key elements for yield potential in wheat genotypes due to their capability and efficiency. However we use cow dung as a source of organic matter and maximum use of nutrients for maximum potential yield in wheat genotypes. The composted organic wastes cannot only act as supplement to chemical fertilizers but may also improve the organic matter status and physico-chemical properties of soil (**Harmsen *et al***., 1994). Moreover, the information on yield potential of genotypes will be helpful to explore the varietal potentiality in maximizing wheat yield and to assist breeding program in selecting lines with higher yield potentials. The present experiment assigned with the following objectives : (i)To investigate the varietal/ genotypic in producing maximum yield under different soil and environmental condition (ii)To estimate the nutrient use efficiency of wheat genotypes and (iii) Support wheat breeding program in selecting the genotypes with relatively higher yield potential.

I. MATERIALS AND METHODS

The present research was carried out at Regional Wheat Research Centre, BARI ,Rajshahi, Bangladesh. During the rabi season from November 2015 to April 2016 to study the effects of nutrient management and genotypes on yield and yield attributes of wheat. In the main plot, 4 levels of soil management recommended fertilizer ($N_{120}P_{30}K_{50}S_{20}$), 100% of recommended fertilizer plus 5.0t/ ha cowdung , 150% of recommended fertilizer plus 5.0 t/ha cowdung , 150% of recommended fertilizer plus 10.0 t/ha cowdung with all the production package of WRC and six genotypes *viz*. BARI Gom 28, BAW 1151(BARI Gom 29), BAW 1161(BARI Gom 30), BAW 1170,BAW 1177 and BAW 1182 in sub–plot. A spit-spit plot design was used for the experiment by assigning nutrient management to the main plot, genotypes to the sub-plots. The treatments were replicated three times. The total number of unit plots in the entire experimental area was 6×4×3 = 72. The size of the each sub- plot was 5m×1m=5 m^2.The experimental field was fertilized with above mentioned levels of nutrient management. Seeds were sown on 30 November 2015 in 25 cm apart rows opened by specially made an iron hand tine. Data of yield and yield attributes were recorded after harvesting. The recorded data were compiled and tabulated for statistical analysis. The data were analyzed statistically and the mean differences among the treatments were adjudged by Duncan's Multiple Range Test (DMRT).

II. RESULTS AND DISCUSSION

The results obtained in this experiment consisting of four nutrient management and six genotypes have been presented in this chapter in tabular and graphical forms. The experiment was performed to examine the effect of nutrient management and six genotypes on the growth and yield and yield contributing characters of wheat.

3.1.1 Total Dry Matter (TDM)

Total dry matter of six wheat genotypes at different stages of growth presented in (Fig. 1a). TDM increased steadily until tillering. and then increased sharply with the advancement of growth period upto physiological maturity.

Table 1. Fertility status of initial soil sample of the experimental site at RWRC, BARI, Rajshahi, BANGLADESH

Sample	P^H	OM (%)	Total N(%)	K	P	Zn	B
				Meq/ 100g		µg/g	
Value	7.8	0.94	0.05	0.21	10	0.14	0.27
Critical level	-	-	0.12	0.12	10	0.60	0.20
Interpretation	Slightly Alkaline	Very low	Very low	Medium	Low	Very low	Very low

Effect of nutrient management

Nutrient management significantly influenced total dry matter at all sampling stages. In case of tillering stage, the maximum dry weight (11.74) found in M_4 nutrient management and minimum dry weight (9.95) in M_1management. During the period of booting stage, highest dry weight (99.24) found in M_4 nutrient management and lowest dry weight (88.15) in M_1 nutrient management. At heading, highest dry weight was obtained at M_4 nutrient management (405.38) and lowest dry weight (380.27) in M_1 nutrient management. Incase of anthesis and physiological maturity, the maximum dry weight (793.04 and 977.99) found in M_4 nutrient management and minimum dry weight (765.20 and 944.07) in M_1 management (Figure 1.a).

Effect of genotypes

TDM varied significantly due to genotypes at tillering without others sampling stages (Fig. 1b). At tillering showed that the highest TDM (12.12) was obtained fromG_6(BAW 1182) which statistically similar in G_5 and the lowest TDM (9.80) was found in G_1(BARI Gom 28). For booting stage, highest TDM (94.74) was obtained from G_6 genotypes and minimum dry weight (91.02) in G_1 genotypes . At heading, highest dry weight in G_6 genotypes (393.84) and lowest dry weight (390.30) observed in G_1 genotypes. Incase of anthesis and physiological maturity, the maximum dry weight (785.31 and 954.15) foundin G_6 genotypes and minimum dry weight (774.56 and 960.41) in G_1 genotypes.

3.1.2 Crop growth rate (CGR)

Effect of nutrient management

Significant differences were observed on CGR at Booting stage-tillering to except other stages. CGR increased significantly with increasing number of nutrient management.(Fig 2a). The highest CGR (3.50) was observed in M_4 which was statistically similar as M_3 due to nutrient management whereas the minimum CGR (3.13)of booting stage-tillering. Plants extended their luxurious growth up to anthesis. The highest CGR (15.31) and lowest (14.60) found in M_4 and M_1 nutrient management at heading stage-booting .However, anthesis- heading showed maximum CGR (25.84) and lower CGR (25.66) in M_4 and M_1 nutrient management. At physiological maturity-anthesis, the highest CGR (12.33) and lowest (11.92) found in M_4 and M_1 nutrient management. During the time of maturity, most of the wheat crops gave similar CGR in both the growing seasons.

Effect of genotypes

Genotypes had not significant effects on CGR at all the growth stages. At Booting stage-tillering showed that the highest CGR (3.30) was obtained from G_6 (BAW 1182) and the lowest CGR (3.25) was found in G_1 (BARI Gom 28) (Fig 2b). For heading stage-booting stage, highest on CGR of genotypes (15.11) and minimum CGR (14.95) obtained from in G_5 genotypes and G_1 genotypes respectively. At anthesis-heading, highest CGR in G_6 genotypes (26.10) and lowest CGR (25.62) gained for G_1 genotypes. Incase of physiological maturity-anthesis, the maximum CGR (12.39) found in G_4 genotypes and minimum CGR (11.25) in G_6 genotypes.

3.3 Relative Growth Rate (RGR) (g g^{-1} day^{-1})

Effect of genotypes

Genotypes was not significant effects on RGR at all the growth stages, butbooting-tillering had significant effects on RGR due to genotypes.(Fig 3) At booting-tillering showed that the highest RGR (0.89) was obtained from G_1(BARI Gom 28) and the lowest RGR (0.082) was found in G_6 (BAW1182). For heading -booting stage, highest RGR of genotypes (0.073) and minimum CGR (0.071) was observedat G_1genotypes and G_6genotypes. For this case, anthesis -heading the highest RGR in G_1genotypes (0.046) and lowest CGR (0.045) was obtained from G_6 genotypes. Incase of physiological maturity-anthesis, the maximum RGR (0.014) found in G_1genotypesand minimum RGR (0.013) in G_6 genotypes.

3.2.4 Leaf Area Index (LAI)

LAI is the ratio of total leaf area to ground cover and typically increases to a maximum after crop emergence. It is evident from the results that leaf area index increased linearly from one growth phase to another.

Effect of nutrient management

The data revealed that different macronutrients and their management did affect leaf area index significantly at all the growth stages without physiological maturity (Table-2). During the stage of tillering, the maximum LAI (0.085) found in M_2 nutrient management and minimum LAI (0.74) in M_1. For this booting stage, highest LAI (1.42) was produced by M_2 nutrient management and lowest LAI (1.16) by M_1 nutrient management which was statistically identical similar with M_3. At heading, highest LAI (2.74) found in M_4 nutrient management and lowest LAI (2.18) in M_1 nutrient management. Incase of anthesis, the maximum LAI (2.90) found in M_4 nutrient management which statistically similar with M_2 and M_3 management and lowest LAI (2.45) in M_1 nutrient management. However, physiological maturity showed that the maximum LAI (0.97) was recorded from M_1 and lowest value LAI (0.96) of M_4 nutrient management.

Effect of genotypes

LAI varied significantly due to genotypes at all sampling stages (Table 2). At tillering showed that the highest LAI (0.96) was obtained by G_3(BAW 1161) and the lowest LAI (0.72) was found in G_1 (BARI Gom 28). For booting stage, highest LAI (1.69) was obtained by G_3genotypes and minimum LAI (1.01) in G_1 genotypes (94.74g). At heading, highest LAI (2.90)was in G_3 genotypes and lowest (2.03) in G_1 genotypes. Incase of anthesis and physiological maturity, LAI (3.04 and 1.11) found in G_3 genotypesand minimum LAI (2.60 and 0.88) in G_6 genotypes. **Cao** and **Moss** (1989) reported that total number of leaves and leaf area were reduced differently in different wheat genotypes .

Effect of interaction

Significant effect was observed on LAI due to the interaction between management and genotypes (Fig. 4) at all the stages. The maximum LAI (0.97) was obtained from the treatment combination of M_3G_3 which was statistically identical similar with M_2G_3 and the lower (0.55) was obtained from the treatment combination of M_1G_1 at tillering. At booting stage, highest (1.78) was recorded from the treatment combination of M_4G_3 which was statistically similar with $M_3G_3$and M_2G_3, however the lower (0.90) was obtained from the treatment combination of M_3G_6. At heading , highest LAI (3.15) produced by due to the interaction between management and genotypes and LAI (1.80) by M_1G_6. Incase of anthesis and physiological maturity, the maximum LAI (3.15 and 1.15) found in the treatment combination of M_2G_3 and M_1G_3 and the lower(2.21and 0.80) was obtained from the treatment combination of M_1G_6.

Availability of sufficient nutrients resulted in higher leaf area, which in turn boosted the photosynthetic activity and ultimately higher dry matter accumulation.

Table 2: Effect of genotypes and nutrient management on Leaf Area Index (LAI) at different stages of wheat

Treatments	Tillering	Booting	Heading	Anthesis	Physiological Maturity
Management					
M_1	0.74c	1.16c	2.18c	2.45b	0.97
M_2	0.85a	1.42a	2.32b	2.80a	0.96
M_3	0.81b	1.11c	2.37b	2.89a	0.97
M_4	0.81b	1.35b	2.74a	2.90a	0.96
LSD(0.05)	0.02	0.05	0.12	0.11	ns
Genotypes					
G_1	0.72d	1.01d	2.03e	2.63cd	0.94bc
G_2	0.78c	1.15c	2.14de	2.69cd	0.97b
G_3	0.96a	1.69a	2.90a	3.04a	1.11a
G_4	0.84b	1.26b	2.68b	2.84b	0.96bc
G_5	0.78c	1.26b	2.40c	2.75bc	0.92cd
G_6	0.74d	1.18c	2.26cd	2.60d	0.88d
LSD(0.05)	0.03	0.06	0.14	0.13	0.05
CV (%)	4.65	4.44	5.39	4.45	7.59

CV= Co-efficient of variation
LSD= Level of significant Difference
M_1= Recommended fertilizer
M_2= 100% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)
M_3= 150% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)
M_4= 150% Recommended fertilizer plus 10 t ha^{-1} cowdung (CD)
G_1= BARI Gom 28
G_2= BAW 1151 (BARI Gom 29)
G_3= BAW 1161 (BARI Gom 30)
G_4= BAW 1170
G_5= BAW 1177
G_6= BAW 1182

Table 3a. Effect of genotypes and nutrient management on yield components of wheat

Treatments	Plant height(cm)	Plant population (m^{-2})	Spike length (cm)	Spikelets spike^{-1}	Grains spike^{-1}	1000 grain weight (g)
Management						
M_1	86.11d	141.66d	10.04	16.72	43.53bc	40.96
M_2	88.63c	153.68c	10.23	16.13	42.91c	39.74
M_3	95.60b	168.92b	10.75	16.85	45.14ab	38.01
M_4	98.26a	188.94a	10.77	16.80	46.33a	43.32
LSD(0.05)	2.65	6.80	ns	ns	3.20	ns
Genotypes						
G_1	89.20b	154.10d	10.43b	16.20	44.35	39.03
G_2	86.67bc	157.97cd	9.94b	16.23	43.97	41.32
G_3	92.84a	161.12bcd	11.17*a*	17.33	47.25	43.45
G_4	78.95d	164.65abc	10.41b	16.53	46.08	38.48
G_5	90.34b	168.38ab	10.33b	16.53	44.43	39.53
G_6	88.41b	172.68a	10.41b	16.95	43.78	41.25
LSD (0.05)	3.25	8.33	0.65	ns	ns	ns
CV (%)	7.48	4.72	7.64	11.05	10.69	12.18

Table 3b: Interaction effect of genotypes and nutrient management on yield and yield contributing characters of wheat

Management X Genotypes	Plant height (cm)	Plant population (m^{-2})	Spike length (cm)	Spikelets spike^{-1}	Grains spike^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})
$M_1 G_1$	91.67a	135.26	10.11cdef	16.45	43.19	42.44	3.05j	4.12	7.17
$M_1 G_2$	85.78abcd	137.37	9.05f	15.67	41.11	40.88	4.40abc	3.68	8.08
$M_1 G_3$	79.44def	139.86	10.64bcde	17.44	46.44	36.15	4.29abcd	3.42	7.72
$M_1 G_4$	84.11bcde	142.75	10.67bcde	16.44	42.89	42.87	4.15bcdef	3.81	7.96
$M_1 G_5$	91.67a	145.80	9.52ef	16.77	43.67	41.27	3.10j	4.29	7.39
$M_1 G_6$	84.00bcde	148.95	10.22cdef	17.55	43.89	42.18	4.12cdef	3.55	7.67
$M_2 G_1$	86.56abc	146.81	9.86def	15.55	44.78	39.39	4.13cdef	3.60	7.72
M_2G_2	88.33abc	149.31	10.10cdef	15.66	40.33	44.88	4.50ab	3.42	7.92
$M_2 G_3$	90.11ab	151.90	10.44bcde	17.22	42.33	42.62	3.50ghi	4.07	7.57
$M_2 G_4$	86.67abc	154.70	9.88def	16.11	45.44	39.73	3.83fg	3.94	7.78
$M_2 G_5$	87.89abc	157.65	11.33abc	16.56	43.89	42.15	4.15bcdef	3.99	8.14
M_2G_6	92.22a	161.71	9.77def	15.67	40.67	43.99	3.97def	3.64	7.61
$M_3 G_1$	90.11ab	160.15	10.42bcde	17.11	45.33	41.84	4.21bcd	4.42	8.63
M_3G_2	83.35cde	163.30	10.32bcdef	16.67	45.33	40.42	4.45abc	4.12	8.57
M_3G_3	90.89a	166.63	10.53bcde	17.78	51.56	37.95	4.20bcde	4.33	8.54
M_3G_4	70.90g	170.39	12.56a	15.00	50.11	34.59	4.11cdef	4.25	8.35
M_3G_5	90.00ab	174.38	10.00def	16.89	46.81	33.18	3.85efg	4.77	8.62
M_3G_6	88.33abc	178.66	10.67bcde	17.67	43.67	40.07	3.25hij	4.81	8.06
M_4G_1	88.44abc	177.76	11.33abc	15.67	44.11	42.95	3.20ij	4.29	7.49
M_4G_2	89.22abc	181.92	10.29bcdef	16.92	49.11	39.09	3.59gh	4.46	8.05
M_4G_3	78.90ef	186.08	10.00def	16.89	50.55	46.58	4.60a	4.25	8.85
M_4G_4	74.11fg	190.77	11.55ab	18.55	43.10	36.74	4.12cdef	4.16	8.28
M_4G_5	91.80a	195.72	10.44bcde	15.89	43.33	41.52	3.40hij	4.72	8.12
M_4G_6	89.07abc	201.38	10.99bcd	16.89	46.89	38.76	3.12j	4.64	7.76
LSD (0.05)	6.50	ns	1.30	ns	ns	ns	0.36	ns	ns
CV (%)	7.84	4.72	7.64	11.05	10.69	12.18	8.22	8.12	5.05

CV= Co-efficient of variation
M_1= Recommended fertilizer
M_2= 100% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)
M_3= 150% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)
M_4= 150% Recommended fertilizer plus 10 t ha^{-1} cowdung (CD)

LSD= Level of significant Difference
G_1= BARI Gom 28
G_2= BAW 1151 (BARI Gom 29)
G_3= BAW 1161 (BARI Gom 30)
G_4= BAW 1170
G_5= BAW 1177
G_6= BAW 1182

3.5 Effect on yield and yield contributing characters of wheat genotypes

3.5.1 Plant height

Effect of nutrient management

Data pertaining to the final plant height as affected by different NPKS levels are given in Table 3a. The analysis of variance revealed that different levels of NPKS differ significantly from each other. Maximum plant height (98.26cm) was attained when NPKS was applied at the rate of 180-45-75-30 plus 10 t/ha against minimum plant height (86.11cm) was observed from M_1 treatments. The plant height increased linearly with each successive increase in NPKS which was attributed to the gradual increase in plant height. These results are in agreement with Ayub *et al*., (2002); Maqsood *et al*., (2001).

Effect of genotypes

Plant height was varied significantly with genotypes . The highest plant height (90.41cm) was recorded in $G_4$and the lowest plant height (78.955cm) was measured in G_4 (Table 3a).

Effect of interaction

Significant effect was observed on plant height due to the interaction between management and genotypes (Table 3b) indicates that the tallest plant (90.80cm) was obtained from the treatment combination of M_4G_5 and the shortest plant (70.90cm) was obtained from the treatment combination of M_3G_4.

3.5.2 Number of Plant population m^{-2}

Effect of nutrient management

Three times plus one additional irrigation of M_4 management plant gave highest plant population per m^2(188.94) and one irrigation plus M_1 management treated plot gave (141.66) population at 5% level of significance (Table 3a).

Effect of genotypes

Genotypes had significant effect on plant population per m^2 at 5% level of significance(Table 3.a).The highest number of plant population per m^2 (172.68) was resulted fromG_6(BAW1180) and lower number of plant population per m^2 (154.10) was produced by G1(BARI Gom 28).

Effect of interaction

Significant effect was not observed on the interaction effect of nutrient management and genotypes. Numerically the highest number of plant population per m^2 (201.38) was found in M_4G_6 treatment combination and lower number of plant population per m^2 (135.26) was produced by M_1G_1 treatment combination (Table 3b).

3.5.3 Spike Length

Effect of nutrient management

Effect of nutrient management significant variation in spike length was not observed with the variation of nutrient management (Table3.a). The G_4 plants had the highest spike length (10.77cm) under M_4 and the M_1 plant had the lowest spike length (10.04cm).

Effect of genotypes

Length of spike varied significantly due to genotypes .G_3 genotypes (BAW 1161) produced the spike Length (11.17cm),whereas the lower spike Length (9.94cm) was observed in G_2 (BARI Gom 29) (Table 3a)

Effect of interaction

Significant effect was not observed on the interaction effect of nutrient management and genotypes. Numerically the highest Spike Length(12.56 cm) was found in M_3G_4 treatment combination and lower spike Length(9.05cm) was produced by M_1G_2 treatment combination (Table 3b).

3.5.4 Number of spikelet's spike^{-1}

Effect of nutrient management

Significant variation in was number of spikelets spike^{-1}not observed with the variation of nutrient management (Table3.a).The G_4 plants had the highest (16.85) number of spikelets spike^{-1}underM_3 and the M_2 plant had the lowest (16.13) number of spikelets spike^{-1}.

Effect of genotypes

Number of spikelets spike^{-1}was not significantly affected by genotypes (Table 3a) . The highest number of spikelets spike^{-1}(17.33) from $G_3$the lowest number of spikelets spike^{-1}(16.20) from G_1 (BARI Gom 28).

Effect of interaction

There was not significant effect in respect of number of spiklets spike^{-1} due to nutrient management and genotypes combination .The highest number of spikelets spike^{-1} (17.67) was obtained from the $M_3G_3$and the lowest number of spikelets spike^{-1} (15.0) was obtained from theM_3G_4combination (Table 3b).

3.5.5 Number of grains spike^{-1}

Effect of nutrient management

Number of grains spike^{-1}was statistically significant over different nutrient management .The highest number of grains per spike(46.33) from M_4 showed and the lowest (42.91) from M_2management (Table 3a)

Effect of genotypes

Number of grains spike^{-1}was not found to be significant in respect of genotypes (Table 3.a).The highest number of grains per spike(47.25) from G_3 showed and the lowest (43.78) from G_6genotypes.

Effect of interaction

Significant difference was not observed in terms ofgrainsspike^{-1} due to the interaction between nutrient management and genotypes. Numerically, the highest number of grainsspike^{-1}(51.56) was produced by the interaction of M_4G_3 and the lowest number of fertile seeds spike^{-1} (40.33) was produced by the treatment combination of M_2G_2 (Table 3. b).

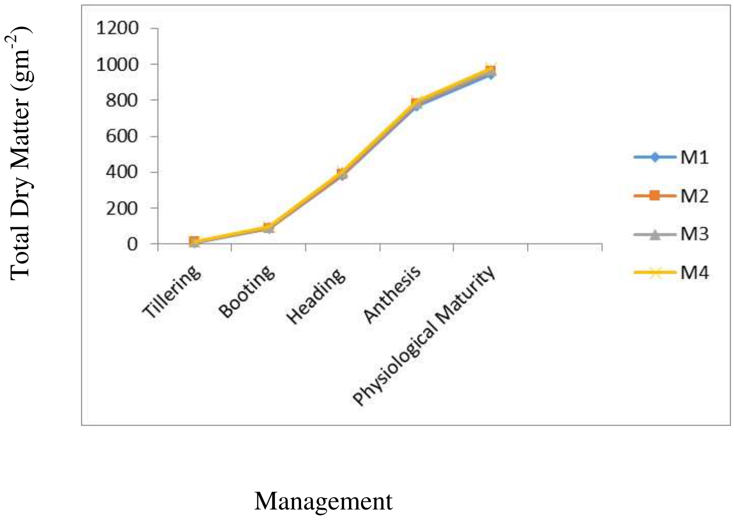


Figure 1a: Effect of nutrient management on Total Dry Matter (TDM) (gm^{-2}) at different stages of wheat genotype

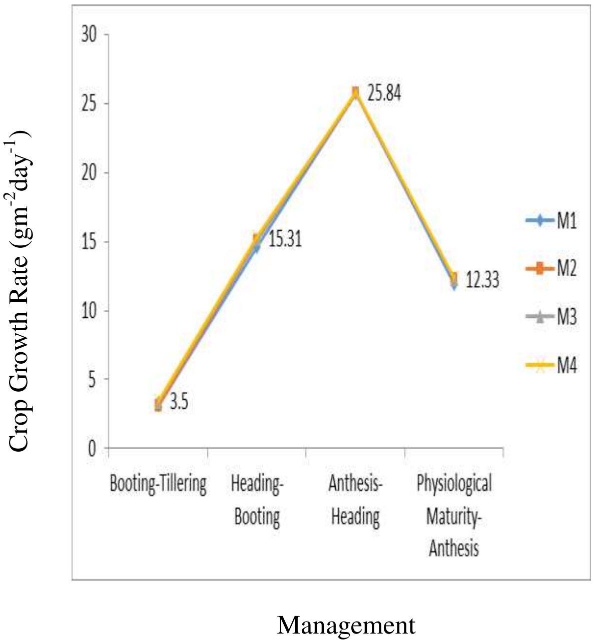
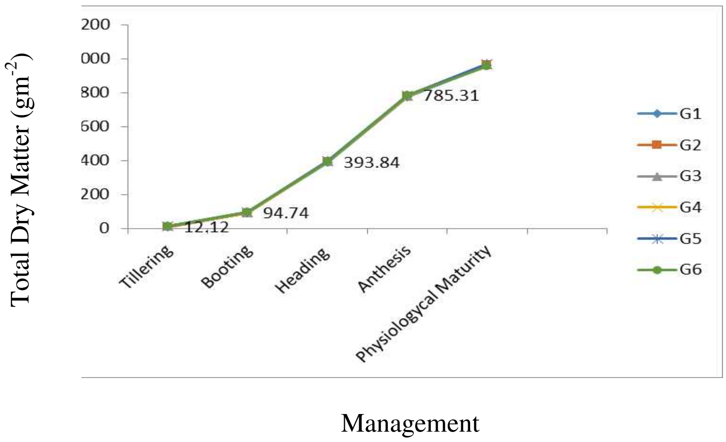


Figure 2a: Effect of nutrient management on Crop Growth Rate (gm^{-2}day^{-1}) at different stages of wheat genotype



Genotypes

Figure 1b: Effect of genotypes on Total Dry Matter (gm^{-2}) at different stages of wheat genotype

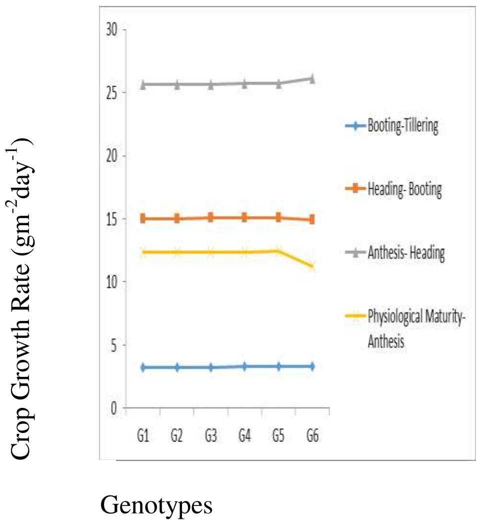


Figure 2b: Effect of genotypes on Crop Growth Rate (gm^{-2}day^{-1}) at different stages of wheat genotype

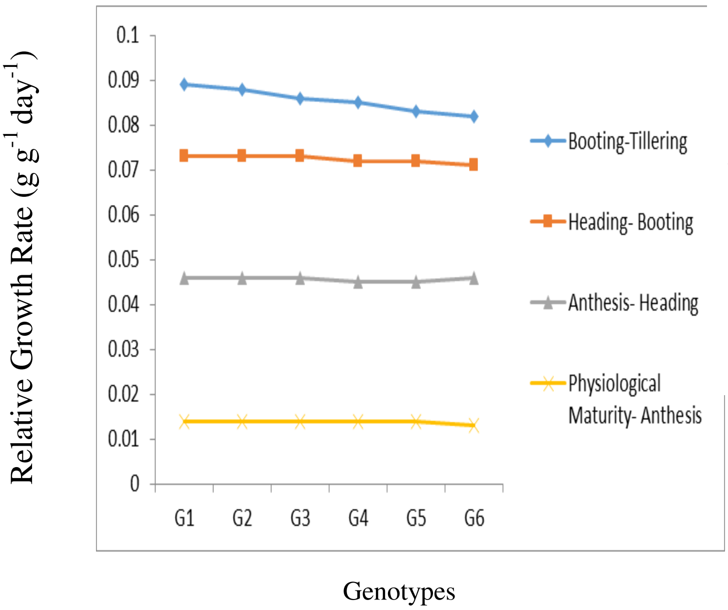


Figure 3: Effect of genotypes on Relative Growth Rate (g g^{-1} day^{-1}) at different stages of wheat genotype

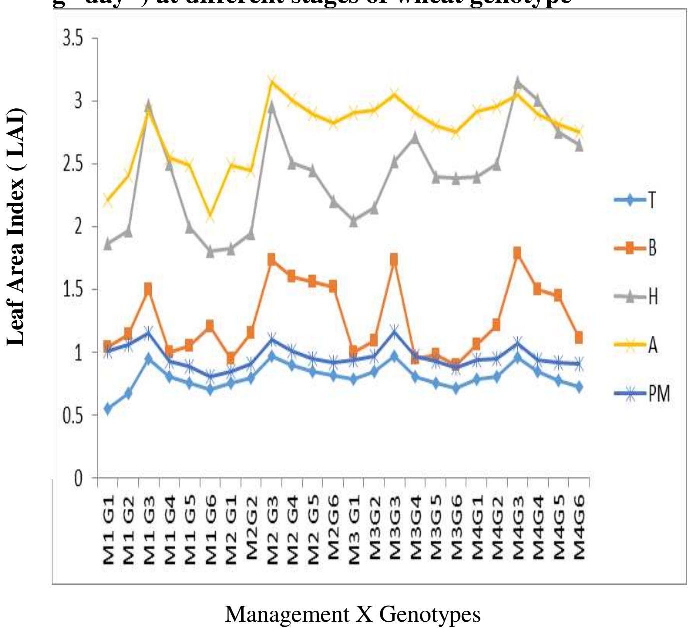


Figure 4. Interaction Effect of genotypes and nutrient management on Leaf Area Index at different stages of wheat genotype

CV= Co-efficient of variation
LSD= Level of significant Difference

M_1= Recommended fertilizer
M_2= 100% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)
M_3= 150% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)
M_4= 150% Recommended fertilizer plus 10 t ha^{-1} cowdung (CD)

G_1= BARI Gom 28
G_2= BAW 1151 (BARI Gom 29)
G_3= BAW 1161 (BARI Gom 30)
G_4= BAW 1170
G_5= BAW 1177
G_6= BAW 1182

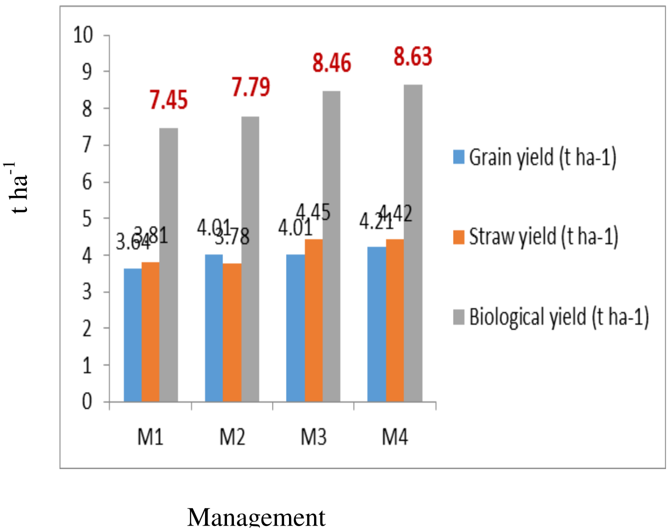


Figure 5a.Effect of nutrient management on yield of wheat genotype

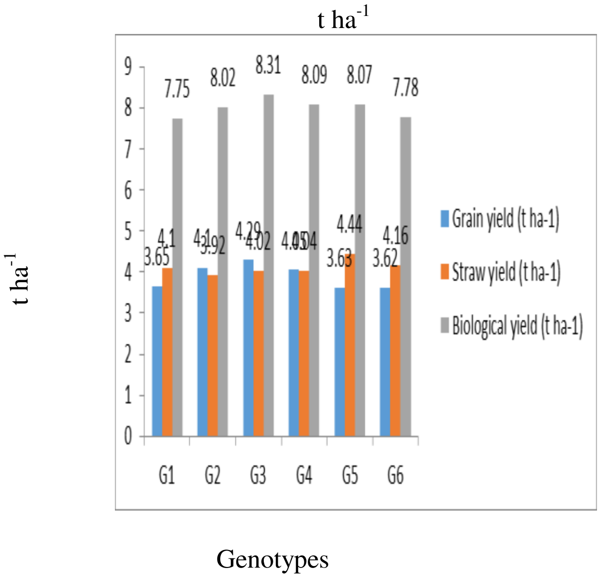


Figure 5b.Effect of genotypes on yield of wheat genotype

M_1= Recommended fertilizer
M_2= 100% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)
M_3= 150% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)
M_4= 150% Recommended fertilizer plus 10 t ha^{-1} cowdung (CD)

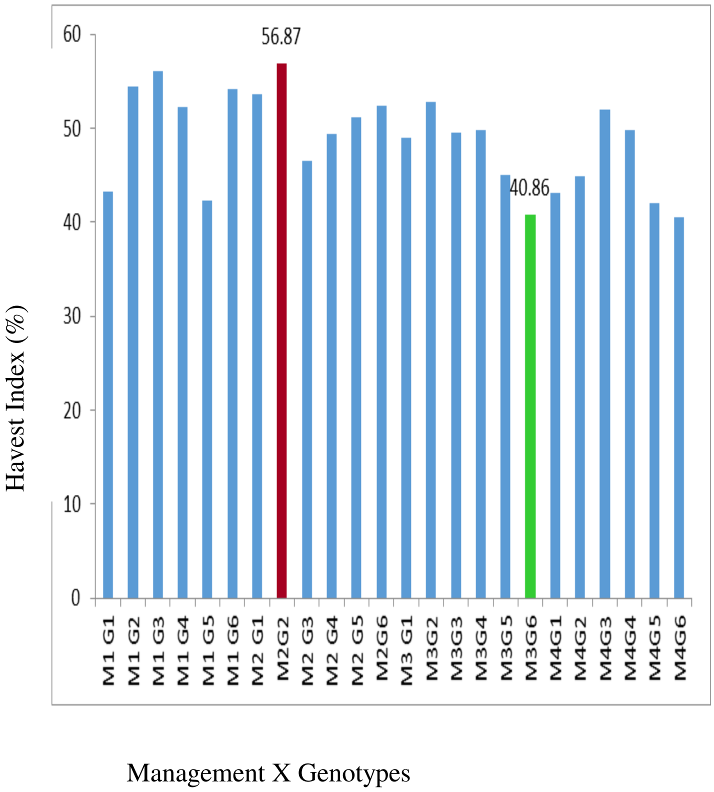


Figure 5c. Interaction effect of genotypes and nutrient management on harvest index

M_1= Recommended fertilizer

M_2= 100% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)

M_3= 150% Recommended fertilizer plus 5 t ha^{-1} cowdung (CD)

M_4= 150% Recommended fertilizer plus 10 t ha^{-1} cowdung (CD)

G_1= BARI Gom 28

G_2= BAW 1151 (BARI Gom 29)

G_3= BAW 1161 (BARI Gom 30)

G_4= BAW 1170

G_5= BAW 1177

G_6= BAW 1182

3.5.6 1000 grain weight (g)

Effect of nutrient management

1000 grain weight was not significantly affected by nutrient management. Numerically, the highest 1000 grain weight (43.32g)was observed M_4 and the lowest (39.74) from M_2management (Table 3a)

Effect of genotypes

Genotypes had not significant effect on 1000-seed weight. G_3gave the higher 1000 grainweight (43.45g) than G_1 (39.03g) (Table 3a).

Effect of interaction

There was no significant effect between nutrient management and genotypes combination on 1000-grain weight. It was varied from 36.58 to 46.58g (Table3.b). Numerically, the highest 1000-grain weight (46.58 g) was obtained from the treatment combination of M_4G_3 and the lowest1000-grain weight (36.58 g) was obtained from the treatment combination of M_1G_3.

3.5.7 Grain yield (t ha^{-1})

Effect of nutrient management

Result showed that nutrient management had significant effect on grain yield at 5% level (Fig.5a).The highest grain yield (4.21 t ha^{-1}) was observed in M_4 management . The lowest grain yield(3.64 t ha^{-1}) was observed in M_1 management.

Effect of genotypes

Grain yield was varied significantly due to genotypes**.** The highest grain yield was obtained in G_3 (4.29 t ha^{-1}) and lowest was (3.62 t ha^{-1}) produced from G_6 (Fig. 5b).

Effect of interaction

The interaction of had significant effect at 5% level of significance on grain yield (Figure). The highest grain yield (4.60 t ha^{-1}) was recorded in M_4G_3 treatment and the lowest grain yield (3.05 t ha^{-1}) was observed in in M_1G_1 treatment (Table 3b).**Chaudhry *et al.*,** (2000) found highest wheat genotype grain and straw yield with NPK @ 120-90-60 Kg ha-1 respectively.

3.5.8 Straw yield (t ha^{-1})

Effect of nutrient management

Straw yield weight was not significantly affected by nutrient management. Numerically, the highest straw yield (4.45 t ha^{-1})was observed in M_3 and the lowest (3.78 t ha^{-1}) from M_2 management (Fig 5a)

Effect of genotypes

Straw yield was varied significantly due to genotypes (figure). The highest straw yield was obtained fromG_5 (4.44 t ha^{-1}) and lowest was (3.92 t ha^{-1})produced from G_1(BARI Gom 28) (Fig 5b)

Effect of interaction

Straw yield was not statistically affected by the interaction of nutrient management and genotypes. The highest straw yield (4.81t ha^{-1}) was observed in M_3G_6treatment combination and the lowest straw yield(3.42 t ha^{-1}) was obtained fromM_1G_3treatment combination (Table 3b).

3.5.9 Biological yield (t ha^{-1})

Effect of nutrient management

Biological yield was not significantly influenced by nutrient management. The highest Biological yield (8.63 t ha^{-1}) was observed in M_4 management. The lowest Biological yield (7.45 t ha^{-1}) was observed in M_1management (Fig 5a)

Effect of genotypes

The biological yield varied significantly due to genotypes. The highest biological yield (8.31 t ha^{-1}) was produced by G_3 (BARI Gom 30) and the lowest biological yield (7.75 t ha^{-1}) was produced by G_1 BARI Gom 28 (Fig 5b).

Effect of interaction

The interaction effect between nutrient management and genotype son biological yield was not statistically significant at 5% level of significance (Fig.5b). The highest biological yield (8.85 t ha^{-1}) was obtained from M_4G_3treatment combination and the lowest biological yield (7.17t ha^{-1}) was resulted from M_1G_1 treatment combination (Table 3b)

3.5.10 Harvest Index (%)

Effect of interaction

The harvest index was affected significantly the interaction between nutrient management and genotypes (Figure).

Numerically, the highest harvest index (56.87%) was found in M_2G_2 treatment combination. The lowest harvest index (40.49%) was recorded fromM_4G_6reatment combination (Table5c)

III. CONCLUSION

The present research was carried out at Regional Wheat Research Centre, BARI , Rajshahi. During the rabi season from November 2015 to April 2016 to study the effects of nutrient management and genotypes on yield, yield attributes and seed quality of wheat. *In the* main plot, 4 levels of soil management recommended fertilizer ($N_{120}P_{30}K_{50}S_{20}$) ,100% of recommended fertilizer plus 5.0t/ ha cowdung , 150% of recommended fertilizer plus 5.0 t/ha cowdung , 150% of recommended fertilizer plus10.0 t/ha cowdung with all the production package of WRCand six genotypes*viz*. BARI Gom 28, BAW 1151(BARI Gom 29), BAW 1161(BARI Gom 30), BAW 1170,BAW 1177 and BAW 1182.. A spit-spit plot design was used for the experiment by assigning nutrient management to the main plot, genotypes to the sub-plots. The treatments were replicated three times. The total number of unit plots in the entire experimental area was 6×4×3 = 72. The size of the each sub- plot was 0.75 m. The experimental field was fertilized with above mentioned levels of nutrient management.

Seeds were sown on 30 November 2015 in 25 cm apart rows opened by specially made an iron hand tine. Data of yield and yield attributes were recorded after harvesting. The recorded data were compiled and tabulated for statistical analysis. The data were analyzed statistically and the mean differences among the treatments were adjudged by Duncan's Multiple Range Test (DMRT).

The overall objective of this study was to improve yield of wheat. Crop growth, growing periods, grain yield and all the yield components of wheat genotypes were affected by nutrient management. Application of NPKS in combination increased wheat yield. gave the highest grain yield (4.21 t ha^{-1}) from M_4 management , due the higher number of Grains $spike^{-1}$ over nutrient management. The highest grain yield (4.29 t ha^{-1}) was recorded from G_3 (BAW 1161) genotypes. Among the interaction of nutrient management and genotypes produced the highest grain yield (4.60 t ha^{-1}) in M_4G_3 (i.e 150% RF+10 t ha^{-1} cow-dung) and BAW 1161 which may be considered as the best treatment combination .

Different genotypes showed variable response to nutrient management. To make maximum use of these wheat genotypes , they must be fertilized with high rates of nitrogen and phosphorus and irrigated adequately .They do not require more fertilizer but they are able to utilize more fertilizer efficiently . However, ongoing practice use modified soil fertility caused by nutrient management and other important elements thereby higher yield of wheat genotypes.

ACKNOWLEDGEMENTS

Authors have no conflict of interest in this research. The author would like to thank Department of Crop Science and Technology, Faculty of Agriculture, University of Rajshahi, Rajshahi-6205 and Regional Wheat Research Centre, BARI , Rajshahi, Bangladesh.

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